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Development of a Wideband Electromagnetic Irradiation Applicator for Chemical Processing

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Microwave heating has been attracting attention from the viewpoint of rapid, efficient and selective chemical reaction. Microwave absorption rate of a material depends on its structure, temperature, and microwave frequency. However almost all the microwave chemical processing experiments were conducted at the frequency band of 2.45 GHz, which is legally allocated for microwave heating as one of ISM (Industrial, Scientific and Medical) bands. The objective of the present study is development of an electromagnetic irradiation applicator which makes various types of chemical processing effective in not only the ISM band but also a wide frequency band.

Figure 1 shows our developed applicator. Electromagnetic waves propagate from the coaxial connector at the input port through the applicator using coaxial cable structure. The coaxial cable does not limit the irradiation frequency theoretically. Distilled water is poured into the applicator as reference. Teflon is installed to prevent the water from leaking. Tapering structure plays an important role in reducing reflection of electromagnetic waves at the boundary between the water and Teflon. There is a punching metal on the end plate of the applicator to relieve pressure without leaking electromagnetic waves.

We conducted numerical simulation by using 3D electromagnetic simulator, and practical experiments, as shown on the left-hand and right-hand sides of Figure 1, respectively. The experimental results were well matched to the numerical simulation results. We successfully developed the applicator with a low reflection rate of less than 10 % from 1.2 GHz to 2.7 GHz. We will conduct chemical processing by electromagnetic irradiation using the developed applicator at various frequencies as future works.

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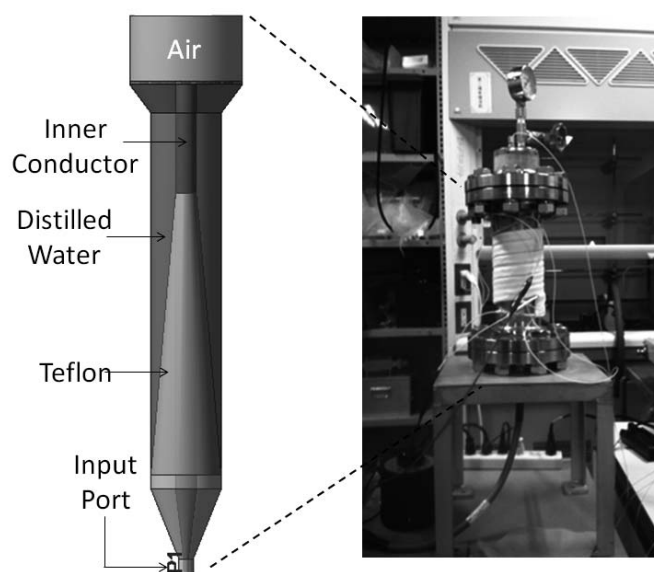


Figure 1. A conceptual image (left) and a photograph (right) of a wideband electromagnetic irradiation applicator.